Autonomous Aerial Power Plant Inspection in GPS-Denied Environments

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INTRODUCTION

- Inspection of coal-fired power plants is frequently dangerous, includes difficult places to reach, and can turn expensive.
- Robotic systems have shown capabilities to address some of these issues, but most current robotic inspection technology in power plants is designed for specific components and either RC controlled or GPS dependant [1].
- A close-range and autonomous inspection method in the GPS-denied environments from a CAD model of power plant is introduced here.
- *Synthetic vision* (used in aerospace industries) inspired approach, using *"Offline trajectory"* complemented with "online trajectory", using two platforms : *a) A quadrotor (external) and b) a low thrust airship (internal inspection)*

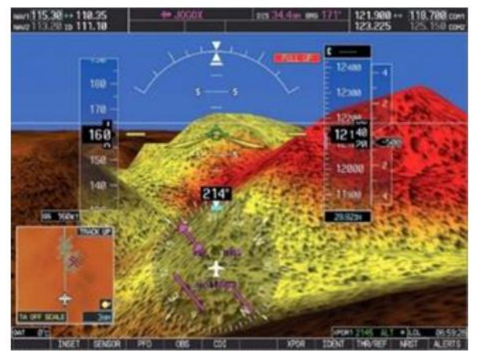

Fig. 1a. Synthetic vision (GARMIN Synthetic Vision Technology)

Fig. 1b. Lighter-than-air low thrust airship (courtesy: industrial partner, AerobotX)

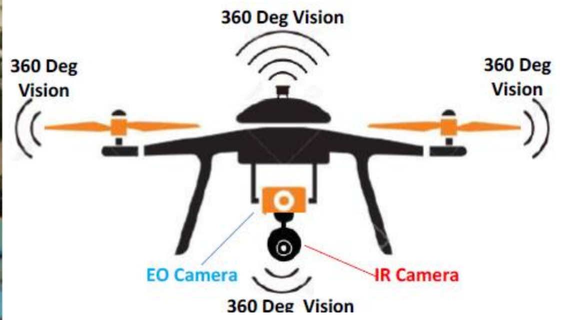

Fig. 1c. A quadrotor UAV

NEED

1. To enable Unmanned Aerial System (UAS*) close quarter inspection* within complex over-head *and Global Positioning System (GPS)-denied environments* of coal-fired power plants, including.
2. Universal reach i.e. *exterior and interior* inspection of structural elements than component specific approaches, specially without disturbing internal particulate (ash) accumulations.
3. Reduces the heightened risks and accessibility limitations of manual/human inspection.
4. Significantly reduced system downtime.

METHODOLOGY

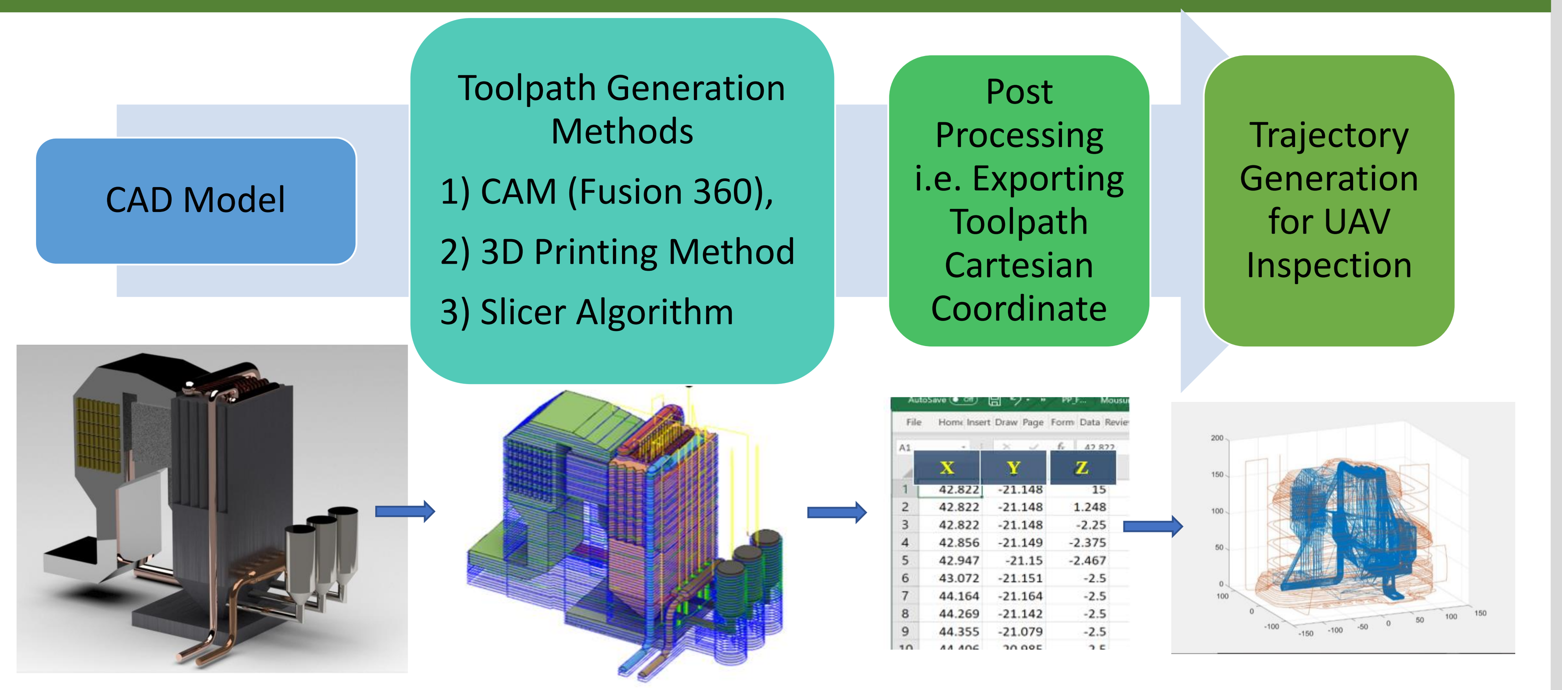

Fig. 2. CAD/CAM-based Methodology

RESULTS

1. Three different CAD-based methods were used to generate the offline trajectories.
2. MATLAB/SIMULINK was used to verify the obtained trajectories.

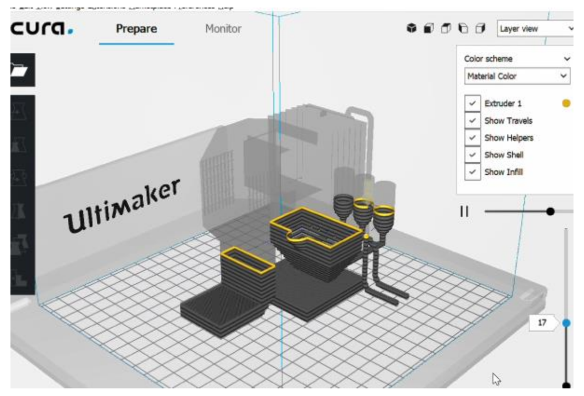

Fig. 3a. Method 2: Additive Manufacturing Method

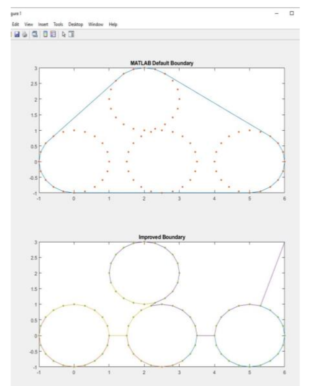

Fig. 3b. Method 3: Slicer Algorithm

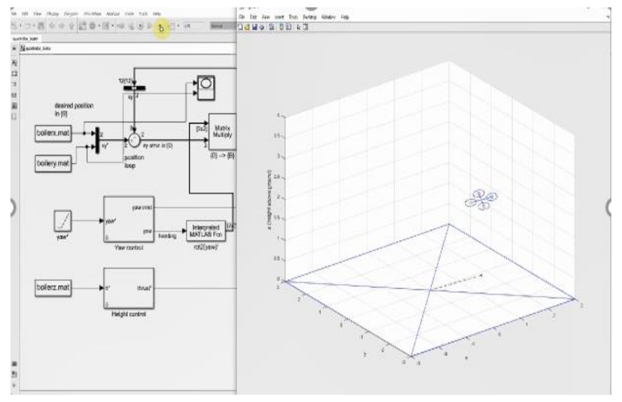

Fig 3c. A screenshot of UAV offline trajectory simulation test using SIMULINK/MATLAB

BENEFITS AND FUTURE WORK

Major Advantages

1. Saves time and cost associated with downtime of the powerplant and minimize human risk.
2. Can equally be used for both external and internal inspections.
3. This is a software/data based system that does not need additional component installation in the UAV, thereby does not affect maneuverability or incur additional cost.

Future work

1. Export trajectory data and yaw data points to flight controller for in flight testing
2. Sync offline and online trajectory generation to work simultaneously
3. Further refine algorithm for universal application

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1. J. Nikolic, M. Burri, J. Rehder, S. Leutenegger, C. Huerzeler and R. Siegwart, "A UAV system for inspection of industrial facilities," 2013 IEEE Aerospace Conference, Big Sky, MT, 2013, pp. 1-8.

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